

Discussion of “Dynamic performance measurement with intangible assets”

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Abstract Carona (2008) investigates the roles of nonfinancial performance indicators and long-term commitments in an incentive contracting setting. The paper develops a multiperiod agency model in which nonfinancial performance indicators are shown to be valuable in providing the agent with desirable incentives. The relative importance of nonfinancial measures depends on the level of commitment that the principal and the agent can sustain. While long-term contracts are more efficient than short-term contracts, the analysis shows that a sequence of overlapping medium-term contracts can be as efficient as long-term contracts. In this discussion, I provide a brief review of the related streams of literature and discuss the paper’s contributions to them. The discussion also illustrates the intuition behind the paper’s main findings through a simple example and raises questions for future research.

Keywords Nonfinancial performance measures · Commitment · Managerial incentive contracts

JEL Classification M41 · D21 · M21

1 Introduction

Carona (2008) examines a multiperiod incentive contracting problem in which a manager must be provided with incentives to invest in intangible assets such as customer satisfaction. The paper relates to two distinct streams of literature in accounting and economics. The first stream of literature has investigated the role of nonfinancial performance measures in managerial compensation contracts. A

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central question in this literature is how to ensure that managers would be willing to sacrifice current performance for potential payoffs in the distant future. For instance, how do we motivate managers with short planning horizons to invest in R&D activities with payoffs that would be realized, if ever, with significant delays? Performance measures based on conventional accounting information offer a potential remedy to this managerial horizon problem. Under accrual accounting, current investment expenditures are initially capitalized as assets and expensed in future periods as the benefits of investments are subsequently realized.

For investments in “soft” assets such as customer satisfaction, however, it is often difficult to separate investment expenditures from regular operating costs. To motivate managers to invest in these intangible assets, firms often include nonfinancial indicators in managerial performance measures. (See Kaplan and Norton (1996) and Ittner and Larcker (1998). Many recent papers have investigated the incentive contracting role of nonfinancial performance measures in formal agency settings. Datar et al. (2001) and Dikolli (2001), among others, study the value of contracting on nonfinancial performance measures in single period models. Dutta and Reichelstein (2003) and Sliwka (2002) examine two-period agency models in which the investment undertaken in the first period yields payoffs in the second period.

The second stream of literature, to which this paper contributes, has investigated the value of commitment in multiperiod agency relationships. Fudenberg et al. (1990) identify circumstances under which short-term contracts can do as well as long-term contracts. They show that the absence of asymmetric information at all contracting dates is one of the key requirements for short-term contracts to replicate the performance of long-term contracts. In the presence of asymmetric information, long-term contracts are usually more efficient than short-term contracts. To resolve the incentive problems created by private information, it is often necessary to commit *ex ante* to *ex post* inefficiencies. See, for instance, Chiappori et al. (1994), Fudenberg et al. (1990), and Rey and Salanie (1990, 1996).

Carona examines a multiperiod LEN model in which an agent must be motivated to exert a personally costly effort as well as to invest in an intangible asset (for example, customer satisfaction). The intangible asset yields a stream of decreasing future cash flows. A maintained assumption is that investments in intangible assets are soft and cannot be separated from regular operating expenses. The paper extends Dutta and Reichelstein (2003) by considering investments that yield payoffs over an infinite horizon and by varying the level of commitment that the principal and the agent can sustain in their contracting relationship. In particular, the paper compares the efficiencies of three different commitment scenarios in which the principal and the agent can commit to: (1) one period contracts (short-term contracts), (2) long-term contracts for the entire contracting horizon of T periods, and (3) overlapping two-period contracts (medium-term contracts). For each commitment scenario, the paper allows for the investment decisions to be either observable or unobservable to the principal.

The most interesting result of the paper is that (regardless of whether the actual investment choices are observable to the principal) a sequence of overlapping two-

period contracts achieves the same performance as an optimal long-term contract.¹ This result is interesting because medium-term compensation contracts seem to be prevalent in the real world employment relationships. Carona's results suggest that there may not be any loss of efficiency in restricting to such realistic contracts. The paper also identifies a class of value-added performance measures, which is optimal for different commitment and observability scenarios.

2 Model

Carona considers a T -period agency relationship between a risk-neutral principal and a risk-averse agent. The agent contributes a productive effort in each period. In addition, the agent can invest in an intangible asset (for example, customer satisfaction) in each period. The aggregate cash flow in period t is given by

$$c_t = e_t - h(b_t) + v \cdot A_{t-1} + \varepsilon_t,$$

where e_t is the agent's effort choice; $h(b_t)$ is the (cash) cost of investment undertaken in period t ; v is the cash flow generated by each unit of intangible asset; A_{t-1} is the units of intangible asset available at the beginning of period t ; and ε_t is a normally distributed random variable. The intrinsic value of intangible asset decays at a constant rate, δ , and can be replenished through new investments:

$$A_t = (1 - \delta) \cdot A_{t-1} + b_t,$$

where b_t denotes the amount of new investment in period t . The investments in intangible asset are not personally costly to the agent. Yet the principal faces an induced incentive problem with regard to these investments because they are not directly contractible.

The first-best investment choice will maximize

$$NPV(b_t) = \omega \cdot b_t - h(b_t),$$

where $\omega \equiv \frac{v}{\delta + r}$ is the present value of the cash flow generated by one unit of investment. Let b^o denote the first-best investment, that is, $h'(b^o) = \omega$. While the accounting system cannot provide a direct measure of the amount of new investment made in a given period, it generates a contractible nonfinancial performance indicator (NFPI) y_t , which is a noisy measure of the intangible asset at the end of period t , in particular, $y_t = A_t + \eta_t$, where η_t is a normally distributed measurement noise term.

The paper employs the multiperiod LEN framework developed in Dutta and Reichelstein (1999). In each period, the agent's compensation S_t is a linear function of his performance measure:

$$S_t = \alpha_t + \beta_t \cdot [c_t + u_t \cdot y_t].$$

Here, α_t is the fixed salary; β_t is the bonus coefficient; and $c_t + u_t \cdot y_t$ is the performance measure. The performance measure is a linear combination of the

¹ Rey and Salanie (1990, 1996) derive a similar result. The relationship to these two papers is discussed in Sect. 4 below.

current cash flow c_t and the nonfinancial performance indicator y_t with the relative weight on y_t given by u_t .

The analysis focuses on a fixed effort scenario in which the principal seeks to induce the maximum amount of effort in each period. Consequently, the bonus coefficients are identical across periods and fixed exogenously at $\beta_t = \theta$ for each t . As part of the LEN framework, the agent is assumed to have additively separable CARA preferences and can borrow and save at the same rate as the principal. Therefore, the principal's choice of compensation contracts does not have to be concerned with the agent's desire for intertemporal smoothing of consumption.

3 Value of commitment

Consider first a commitment scenario in which the principal and the agent can commit at the outset to a long-term contract for the entire employment horizon of T periods. Carona assumes that while the two parties can commit to a long-term contract, they are unable to commit not to renegotiate the contract at subsequent dates. His analysis thus focuses on renegotiation-proof long-term contracts.²

Since the agent discounts the future at the same rate as the principal and the bonus coefficients are exogenously fixed to be identical across periods, a long-term contract based on cash flows alone (that is, $u_t = 0$ for each t) would be enough to make the agent properly internalize the investment returns realized during his employment. It therefore follows that a long-term contract would induce the first-best investment in each period if

$$u_1 = u_2 = \dots = u_{T-1} = 0,$$

and

$$u_T = \omega.$$

To see this, note that the agent internalizes the investment payoffs for the first T periods directly through realized cash flows. Setting the weight on the NFPI equal to the capitalization factor ω in the last period ensures that the agent also internalizes the investment returns that will be realized after his employment ends with the firm. This choice of weights on the nonfinancial performance indicators would indeed be optimal if the NFPI in the last period were free of measurement error, that is, $y_T = A_T$.

Since the NFPI is subject to measurement error in each period, however, the agent's investment incentives must be balanced against the cost of imposing risk. Consequently, as shown in Proposition 2 in Carona, the optimal long-term contract induces underinvestment in each period and the optimal coefficients on NFPIs satisfy

² Carona allows for investments to be unobservable as well as observable (but not verifiable). My discussion focuses on the case when investments are unobservable, since this scenario poses a more challenging incentive problem.

$$0 < u_1 < u_2 < \dots < u_T < \omega.$$

When the two parties can only commit to one period contracts, the agent rationally anticipates that the principal will act opportunistically in setting the terms of future contracts. The agent thus disregards future investment payoffs in making his current investment decision. To provide the manager with investment incentives, it becomes essential to include the NFPI in the agent's performance measure.

To illustrate the value of commitment, it is useful to consider a special case in which $y_t = A_t + \eta_t$ for $t \in \{1, \dots, T-1\}$, but $y_T = A_T$. That is, the NFPI measures the value of the intangible asset with error in each of the first $T-1$ periods but provides a *perfect* signal in the last period. As noted earlier, in this case, long-term contracting allows the principal to induce the first-best investment in each period without exposing the agent to the risk associated with noisy NFPIs. The optimal long-term contract is characterized in Table 1 below.

As long as the nonfinancial indicator in the last period provides a noiseless estimate of the intangible asset, long-term contracting allows the principal to insulate the agent from all of the risks associated with NFPIs in the earlier periods and yet induce the first-best investment in each period. In contrast, without a long-term commitment, provision of investment incentives requires that the agent's compensation be contingent on the noisy NFPI in each period. Table 2 below provides a characterization of the optimal short-term contracts.

A direct comparison reveals that short-term contracts are inefficient, since they (1) expose the agent to the risk associated with the noisy NFPIs, and (2) induce the agent to invest less than the first-best amount in each of the first $T-1$ periods.

One of the main results of the paper is that all the efficiencies of long-term contracting can be captured with a much lower level of commitment between the two parties. In particular, the paper shows that the performance of long-term contracts can be replicated by a sequence of overlapping two period contracts. To illustrate this result, let us consider a three-period model (that is, $T = 3$). Under this "medium-term" contracting scenario, the principal and the agent

- Sign a two-period contract $\{S_1, \hat{S}_2\}$ at date 0,
- Renegotiate the remaining portion of the original contract; that is, \hat{S}_2 , to a two-period contract $\{S_2, S_3\}$ at date 1.

Table 1 Optimal long-term contract

Period	1	2	...	T
NFPI	Noisy	Noisy	...	Noiseless
Optimal weight u_t	0	0	...	ω
Investment b_t	FB	FB	...	FB

Table 2 Optimal short-term contract

Period	1	2	...	T
NFPI	Noisy	Noisy	...	Noiseless
Optimal weight u_t	>0	>0	...	ω
Investment b_t	$<FB$	$<FB$...	FB

If the agent believes that contract \hat{S}_2 would be replaced with a new (extended) contract $\{S_2, S_3\}$ at date 1, then he would essentially behave as he would under the long-term contract $\{S_1, S_2, S_3\}$. The “off-equilibrium” contract \hat{S}_2 would then have no impact on the agent’s investment and effort incentives. Of course, it must be incentive compatible for both the principal and the agent to replace \hat{S}_2 with $\{S_2, S_3\}$ at date 1. These incentive-compatibility requirements are not trivial since the renegotiation takes place under asymmetric information: the agent knows his investment choice in the first period, but the principal does not.

Since the intuition for this equivalence result is not very transparent, it is useful to explicitly construct a sequence of two-period contracts that attain the same performance as an optimal long-term contract. Let us again consider a stark setting in which the nonfinancial indicators are noisy in the first two periods but perfect in the last period. As observed earlier, the optimal long-term contract will induce the first-best investment in each period without exposing the agent to the risk associated with y_1 and y_2 . Let $S_t = (\alpha_t, u_t)$ denote the contract for period t .³ An optimal long-term contract is then given by $\{(\alpha_1^*, 0), (\alpha_2^*, 0), (\alpha_3^*, \omega)\}$. The fixed salary parameters α_1^* , α_2^* , and α_3^* are chosen so that, conditional on first-best investments, the certainty equivalent of the agent’s compensation in each period is exactly equal to his reservation wage of zero. That is,

$$\alpha_1^* + \theta[\bar{e} - h(b^o)] - g(\bar{e}) - \rho \cdot \theta^2 \cdot \sigma^2 = 0, \quad (1)$$

$$\alpha_2^* + \theta[\bar{e} - h(b^o) + v \cdot b^o] - g(\bar{e}) - \rho \cdot \theta^2 \cdot \sigma^2 = 0, \quad (2)$$

and

$$\alpha_3^* + \theta[\bar{e} - h(b^o) + v \cdot A_2 + \omega \cdot A_3] - g(\bar{e}) - \rho \cdot \theta^2 \cdot \sigma^2 = 0, \quad (3)$$

where $A_2 = (1 - \delta) \cdot b^o + b^0$ and $A_3 = (1 - \delta)^2 \cdot b^o + (1 - \delta) \cdot b^o + b^0$. This contract is optimal because it induces optimal effort and investment choices and meets the agent’s ex ante participation constraint.⁴

We now wish to show that there exists a sequence of two-period contracts that attains the same performance as the optimal long-term contract identified above. Suppose that the two parties sign an initial contract $\{(\alpha_1^*, 0), (\hat{\alpha}_2, \omega)\}$, where α_1^* is as given by Eq. 1. The parameter $\hat{\alpha}_2$ is again chosen so that the certainty equivalent of the agent’s compensation in period 2 is equal to his reservation wage if he invests the first-best amounts in each period. That is,

$$\hat{\alpha}_2 + \theta[\bar{e} - h(b^o) + v \cdot b^o + \omega \cdot A_2] - g(\bar{e}) - \rho \cdot \theta^2(\sigma^2 + \omega^2 \cdot \mu^2) = 0. \quad (4)$$

While this initial contract exposes the agent to the risk associated with the noisy NFPI in the second period, the agent does not bear this risk on the “equilibrium” path as this initial contract is ultimately replaced with a contract in which $u_2 = 0$.

³ Since the bonus coefficients are exogenously fixed at $\beta_t = \theta$ in each period, a single period contract S_t is completely described by the pair (α_t, u_t) .

⁴ However, it is not necessary for optimality that the fixed salary parameters take the values given by Eqs. 1–3. Neither the principal nor the agent cares about the timing of payments, and therefore these parameters can be structured in any manner as long as the agent’s ex ante participation constraint is satisfied.

In particular, the second-period contract $(\hat{\alpha}_2, \omega)$ is subsequently renegotiated to a two-period contract $\{(\alpha_2^*, 0), (\alpha_3^*, \omega)\}$ at date 1, where the fixed salary parameters, α_2^* and α_3^* , are given by Eqs. 2 and 3, respectively.

Suppose that, in the first period, the agent makes his investment decision believing that the second period contract $(\hat{\alpha}_2, \omega)$ will be ultimately replaced with $\{(\alpha_2^*, 0), (\alpha_3^*, \omega)\}$. The agent then faces the same investment incentives as he would under the long-term contract $\{(\alpha_1^*, 0), (\alpha_2^*, 0), (\alpha_3^*, \omega)\}$, and he will invest the first-best amount. Consider now the agent's investment incentives if he does not plan to renegotiate his original contract. Since the original contract assigns weight ω to the NFPI in the second period, the agent will again choose to invest the first-best amount in each of the two periods covered by the original contract. Furthermore, given the above choice of $\hat{\alpha}_2$, α_2^* , and α_3^* , the agent is indifferent between contracts $(\hat{\alpha}_2, \omega)$ and $\{(\alpha_2^*, 0), (\alpha_3^*, \omega)\}$. Thus, these medium-term contracts ensure that the agent (1) invests the first best amount in each period, and (2) weakly prefers to extend the contract at date 1.

On the other hand, the principal is strictly better off by renegotiating contract $(\hat{\alpha}_2, \omega)$ and extending it to $\{(\alpha_2^*, 0), (\alpha_3^*, \omega)\}$. To see this, note that if the principal does not offer a new contract at date 1, she has to compensate the incumbent agent in the second period according to the original contract $(\hat{\alpha}_2, \omega)$. Consequently, the principal will have to reimburse the agent for bearing the risk associated with the noisy performance indicator y_2 . Furthermore, if the incumbent agent is let go after the second period, the best that the principal can do is sign a one-period contract (α_3^*, ω) with a new agent in the last period. Hence, relative to the case when the original contract is not renegotiated, extension of the original contract through renegotiation allows the principal to lower her expected compensation cost in the second period.⁵ It therefore follows that the performance of an optimal long-term contract can be attained through a sequence of two-period contracts.

It is useful to relate this finding of equivalence between medium-term and long-term contracts to seemingly identical results obtained in Rey and Salanie (1990, 1996). Rey and Salanie (1990) obtain this equivalence result in a repeated moral hazard setting when there is symmetric information at each possible contracting date. However, the assumption of symmetric information rules out adverse selection problems when the agent has superior information about some productivity parameter as well as moral hazard problems in which the agent becomes privately informed because of his past actions that affect future outcomes. Rey and Salanie (1996) show that medium-term contracts can be as efficient as long-term contracts in standard adverse selection settings; that is, when the agent's private information results from his superior knowledge of productivity. Carona extends this equivalence result to asymmetric information settings in which the agent's private information is a result of past hidden investment choices that affect future cash flows.

⁵ It can be verified from Eqs. 2 and 4 that the principal's savings are $\rho \cdot \theta^2 \cdot \omega^2 \cdot \mu^2$, since $E[\hat{S}_2] = E[S_2] + \rho \cdot \theta^2 \cdot \omega^2 \cdot \mu^2$.

4 Accounting performance measures

Carona shows that the optimal performance measure can be represented as the product of a conventional accounting aggregation process. In particular, the paper derives a class of value-added performance measures, which is shown to be optimal for different commitment scenarios. When the NFPI provides a noiseless estimate of the intangible asset, this value-added performance measure coincides with the familiar residual income measure.

To illustrate this accounting representation, note that the fair value (that is, the present value of future cash flows) of the intangible asset created in period t is

$$f_t = \omega \cdot b_t = \omega \cdot [A_t - (1 - \delta) \cdot A_{t-1}].$$

Since b_t is the agent's private information, the accounting system cannot record the intangible asset at this value. However, a noisy, but unbiased, estimate of the asset's fair value can be obtained by replacing A_t with its unbiased estimate of y_t . Accordingly, the book value of the intangible asset becomes

$$B_t = \omega \cdot [y_t - (1 - \delta) \cdot y_{t-1}].$$

Carona shows that if this asset is depreciated according to the so-called *declining balance depreciation schedule* and the clean surplus relationship holds, then residual income in period t becomes equal to

$$RI_t = e_t - h(b_t) + \omega \cdot b_t + \text{noise}.$$

Under declining balance depreciation schedule, therefore, residual income effectively combines the raw cash flow information and the NFPI signal so as to reflect the present value of returns from the current investment (that is, $\omega \cdot b_t$) in the same period. Consequently, if residual income is used as the performance measure, the agent will choose the first-best investment in each period.

Residual income would indeed be an optimal performance measure if the NFPI provided a noiseless estimate of the intangible asset. Since the NFPI measures the intangible asset with error, however, inducing the first-best investment is not optimal because it requires exposing the agent to too much risk. The principal trades off the agent's investment incentives against the cost of imposing risk, and optimally induces underinvestment. To attain the optimal performance, Carona suggests modifying the residual income measure to a value-added metric, which calibrates the agent's risk exposure through the choice of coefficient m_t :

$$VA_t = e_t - h(b_t) + m_t \cdot \omega \cdot b_t + \text{noise}.$$

This performance measure will provide optimal investment incentives provided that the coefficients m_t are chosen appropriately.

However, the value-based performance measure identified above is consistent with "conventional" accounting only when the calibration coefficient $m_t = 1$. But $m_t = 1$ is optimal only under the exceptional scenario when the nonfinancial performance indicator is perfect, that is, $y_t = A_t$ for each t . Given this limitation, it is not apparent how this particular form of aggregating raw information is any more compelling than the simple linear aggregate given by $c_t + u_t \cdot y_t$.

5 Conclusion

Carona extends the earlier work on the nonfinancial performance measures by studying a setting in which investments generate payoffs extending beyond the agent's planning horizon. In addition, and more significantly, his paper contributes to our understanding of the value of commitment in multiperiod agency relationships. The analysis shows that a limited commitment scenario, where the parties negotiate a sequence of two-period contracts, can yield the same performance as attained with long-term contracting.

This equivalence between medium-term and long-term contracts is derived in a multiperiod LEN framework. The LEN model provides an analytically tractable framework, but this tractability requires some strong assumptions: (1) contracts are linear and performance measures are normally distributed; (2) the agent's risk preference can be represented by an additively-separable CARA utility function; and (3) the agent can borrow and save at the same rate as the principal. It would be interesting to investigate which assumptions of the LEN framework, if any, are crucial for the equivalence result. For instance, would the equivalence result continue to hold if compensation contracts were allowed to be non-linear; that is, if assumption (1) of the LEN framework were dropped?

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